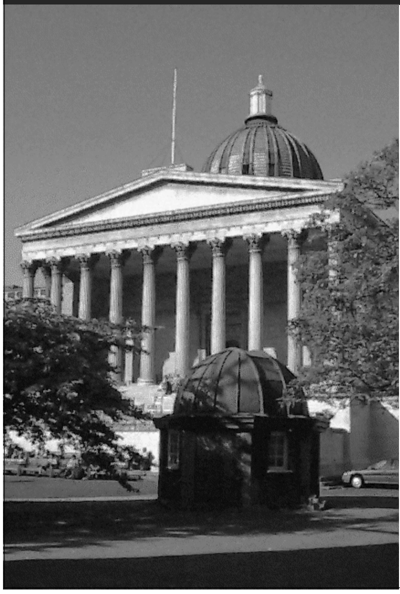

Managing Web Service Quality

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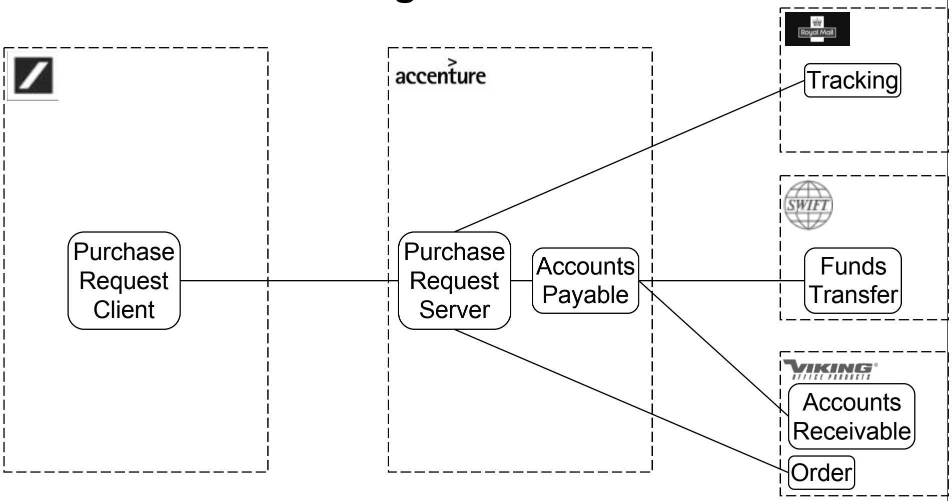
University College London
http://sse.cs.ucl.ac.uk

Setting the scene

"Deutsche Bank AG has agreed to outsource two internal business processes to Accenture Ltd. as part of its ambitious program to cut costs and increase efficiency by moving non-core operations to external service providers. Under the service agreement announced Thursday, Deutsche Bank will outsource its worldwide corporate purchasing and accounts payable services to Accenture. The global consultancy and software development group, located in Hamilton, Bermuda, will provide IT systems and tools to manage the bank's entire procurement-to-payment process."

[Source: IDG, 30 Jan 2004]

Setting the scene



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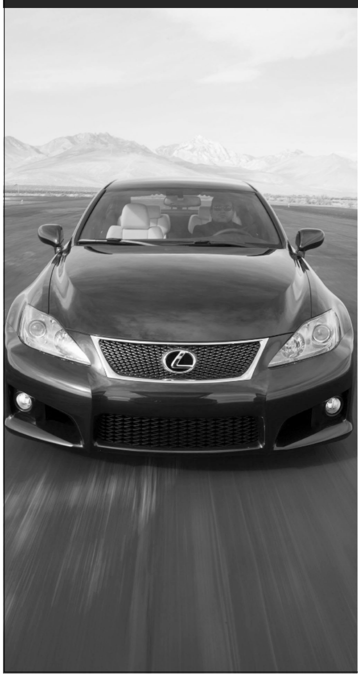
Web Service Quality



- Current SOA standards mainly focus on functionality
- But organizations depend on quality of services provided by 3rd parties
- Their service needs to be delivered with agreed quality
  - Availability / Timeliness
  - Reliability
  - Confidentiality
  - Integrity, …

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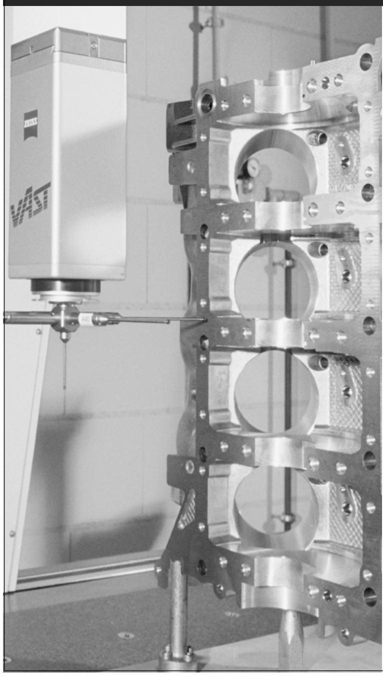

Quality Management

- Testing web services alone is insufficient because service quality determined by
  - Resource provision available in the run-time environment
  - Service usage profile
- For web services, we need to
  - have quality norms and standards
  - know how to measure quality
  - have continuous quality monitoring
  - use quality criteria for service selection
- These need to be reified at run-time

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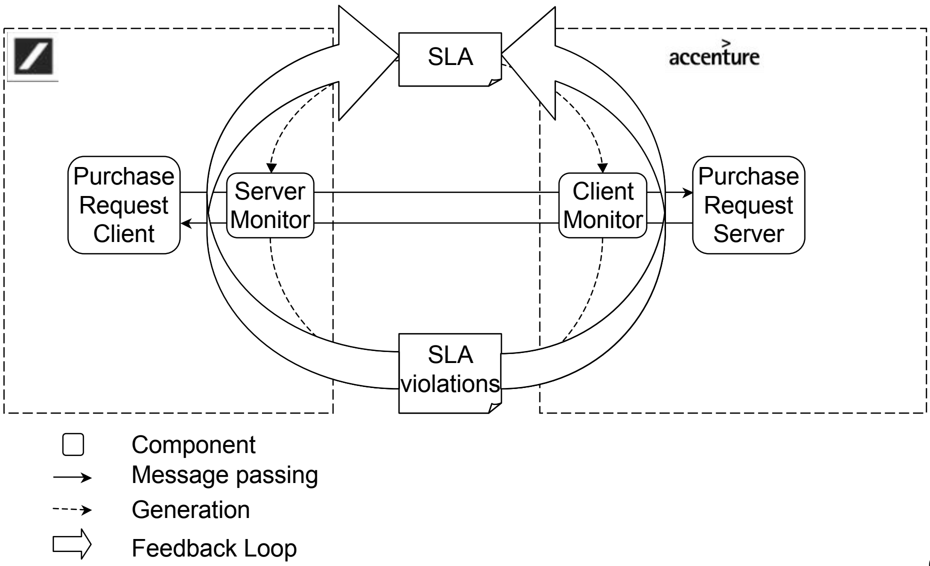
Managing quality in WS Architectures



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Service Level Agreements

- Associate penalties to aberrant service behaviour
- Are often part of service delivery contracts
- Mitigate risk
- Previously mostly written in natural language
  - Ambiguous
  - Incomplete
  - Inconsistent
- We focus on SLAs in formal languages

Service Level Agreements

- Determine required and provided service quality
- Written in terms of
  - Non-functional requirements
  - Usage constraints
- Often annexed to a service provision contract
- Bi-lateral
- Bi-directional

SLA content

SLAs determine conditions, e.g.
- Reliability
- Timeliness
- Availability
- Throughput
- Backup

May include terms determining
- Monitorability
- Penalties
- Administration
- Schedules of applicability

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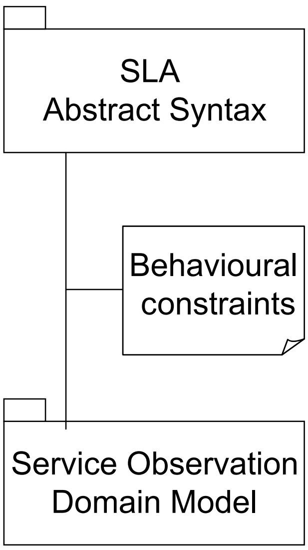

SLA Language Engineering

- Aim: defining precise and unambiguous SLAs language
- Use OMG's Meta Object Facility (MOF) to define
  – Abstract syntax of SLA language
  – Service observation domain model
- Define semantics of SLA langu-age in model denotational style
  – Behavioural constraints between syntax and domain model

See: J. Skene, D.D. Lamanna and W. Emmerich: Precise Service Level Agreements. Proc. ICSE 04

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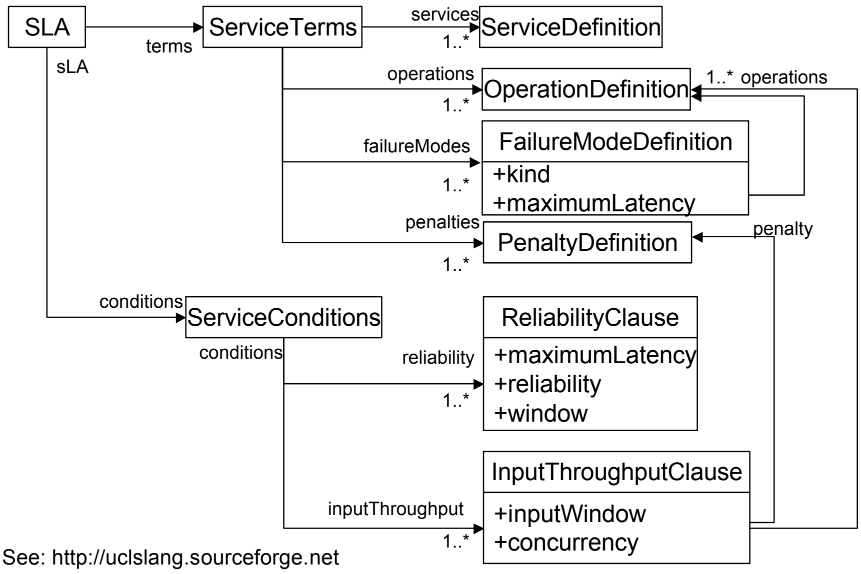
Syntax definition for web service SLAs in MOF



See: http://uclslang.sourceforge.net

SLA in OMG Human readable Textual Notation

```
SLA() {
 terms = ServiceTerms[terms]() {
  penalties = {
    ::slang::PenaltyDefinition[p1]("Pay client 100 dollars.")
  }
  services = ServiceDefinition[service](Notification port")
  operations = {
    OperationDefinition[o1]("notify") { }
    OperationDefinition[o2](”subscribe") { }
  }
  failureModes = {
   FailureModeDefinition[f1]() {
    kind = OPERATION;
    operations = {OperationDefinition[o1]}
    maximumLatency = ::types::Duration(5, S)
   }
  }
 }
```

SLA in HUTN (cont'd)

```
conditions = ServiceConditions[conditions]() {
 inputThroughput = {
  InputThroughputClause[iTC1]() {
   inputWindow = ::types::Duration(1, min)
   inputConcurrency = 10
   operation = {OperationDefinition[o1]}
  }
 }
 reliability = {
  ReliabilityClause[rC1]() {
   failureModes = {FailureModeDefinition[f1]} // When > 5 secs
   reliability = ::types::Percentage(0.9)
   window = ::types::Duration(1, min)
   penalties = {
    UnreliabilityPenaltyClause() {
      penalty = ::slang::PenaltyDefinition[p1]
    }
   }
  }
 }
}
```

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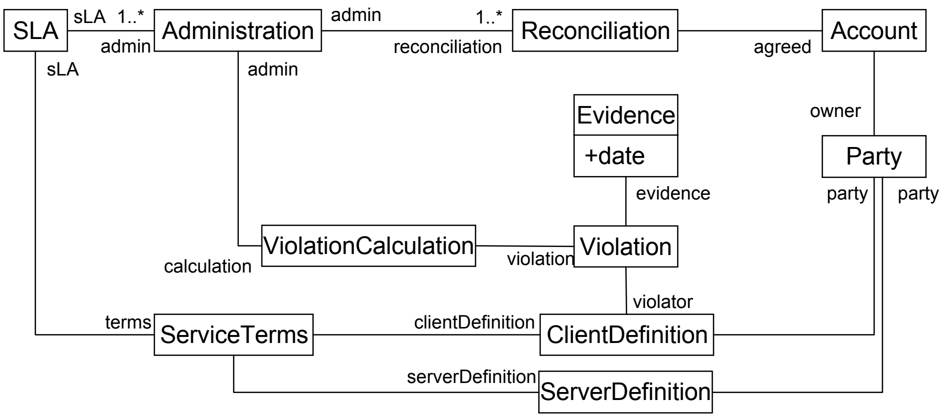
Further SLA syntax: Administration



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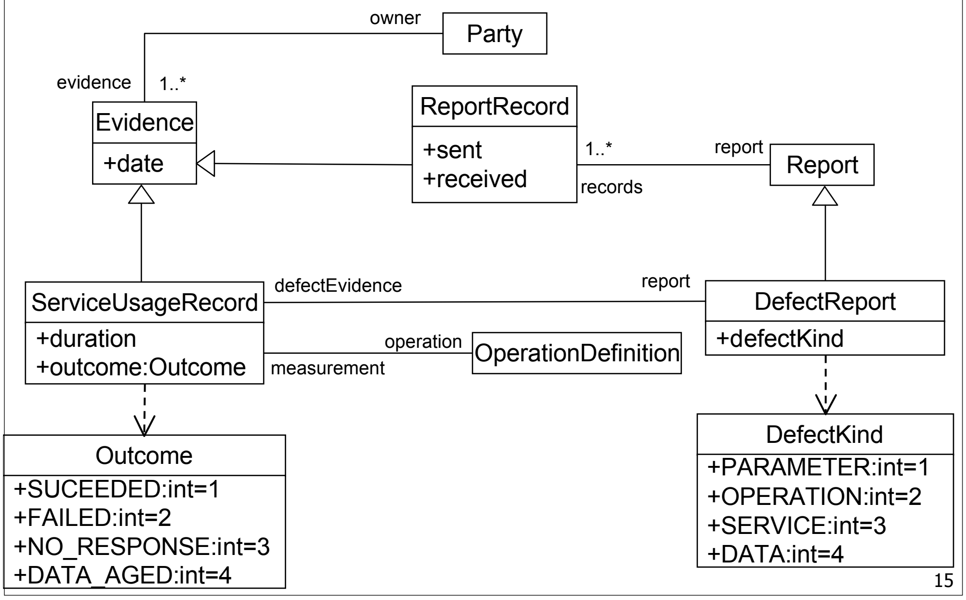
Service observation domain model



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Semantics of input-throughput clause

```
class InputThroughputClause {
invariant {
 conditions.sLA.admin->forAll(
  a : ::services::Administration |
   violationFirstUsage(a.reconciliation.agreed)->forAll(
    first : ::services::es::ServiceUsageRecord |
     a.calculation.violation->one(
      v : ::services::Violation |
       v.violator = conditions.sLA.terms.clientDefinition.party
       and v.violatedClause = self
       and v.penalty = penalty
       and v.evidence =
              violationEvidence(a.reconciliation.agreed, first)
     )
   )
 )
}
```

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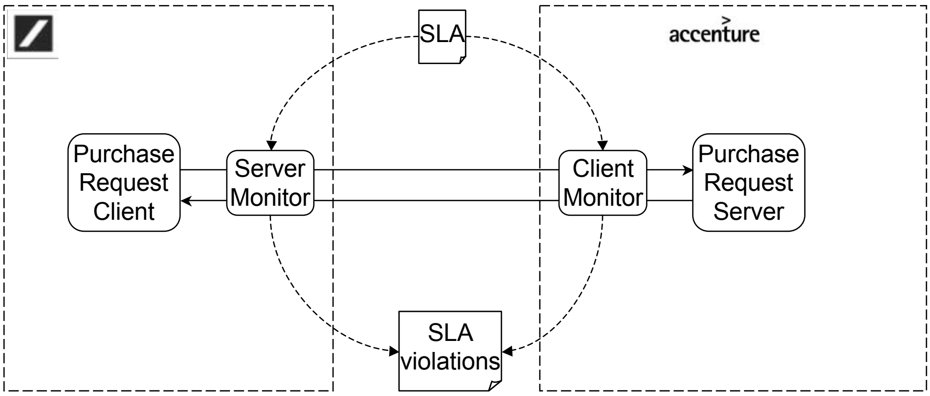
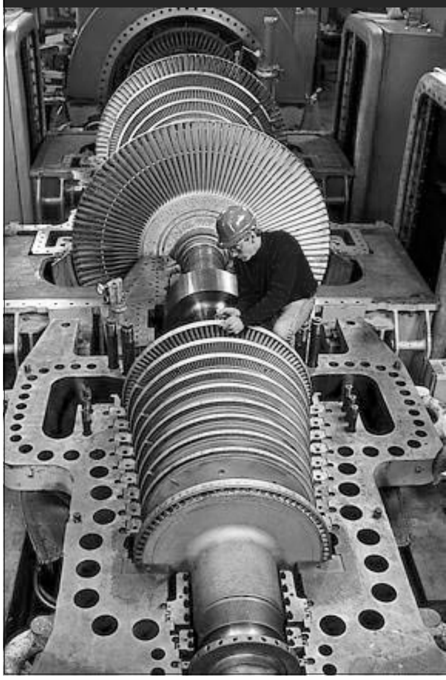
Reminder





Generating SLA Monitors

- SLAs machine readable
- MOF gives standard representation
- Idea: Generate monitoring component from SLA
- Given service observation data monitor decides whether actual service level complies with SLA
- Generator written using
  - Java Metadata Interface (Sun)
  - Eclipse Platform

Key idea

- SLAs concern many timeliness constraints:
  - Latency
  - Input and Output Throughput
  - Reliability
  - Availability
- Events can be intercepted and time stamped without changing web service requester and provider
- Monitors can be expressed using *timed automata*
- Detection of SLA violations reduces to acceptance of timed words that consist of timed events

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Timed Automata

- A time sequence is a sequence of real numbers $\tau=\tau_1\tau_2\ldots\tau_n$ such that $\tau_i>\tau_{i-1}$.
- A timed word is a pair (w,τ) where w is a word of length n and t is a time sequence of length n
- Timed automata extend finite automata in the following way:
  - They introduce a set of clocks
  - They allow definition of time constraints over transitions
  - They allow to reset clocks.
- Timed automata accept timed words and recognize timed languages.

See: Alur & Dill, 1994: A Theory of Timed Automata. Theoretical Computer Science 126(2):183-253

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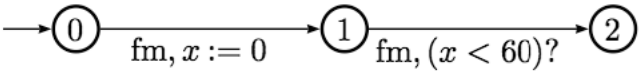
Expressing Web Service Reliability Constraints

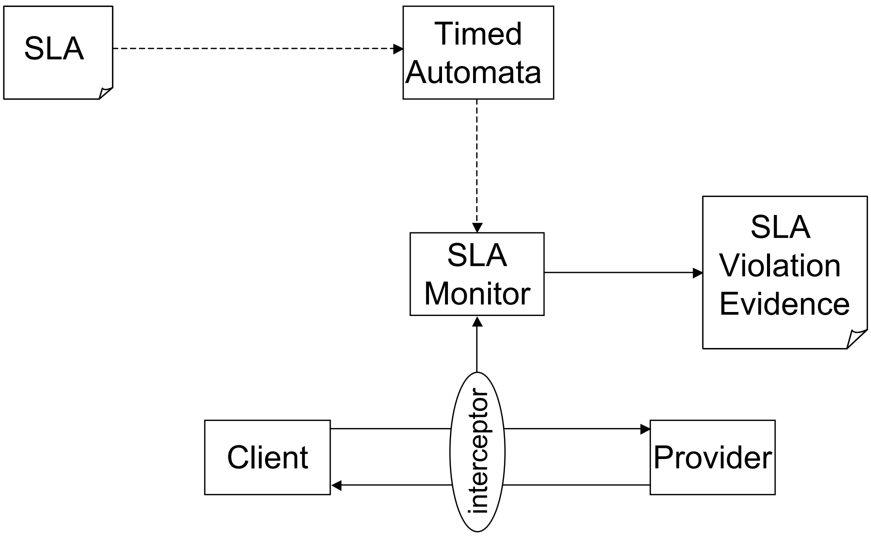
- Negate constraint (i.e. timed automaton accepts timed word that indicates non-reliability)
- In this example, no more than one failure occurrence (fm) per minute.



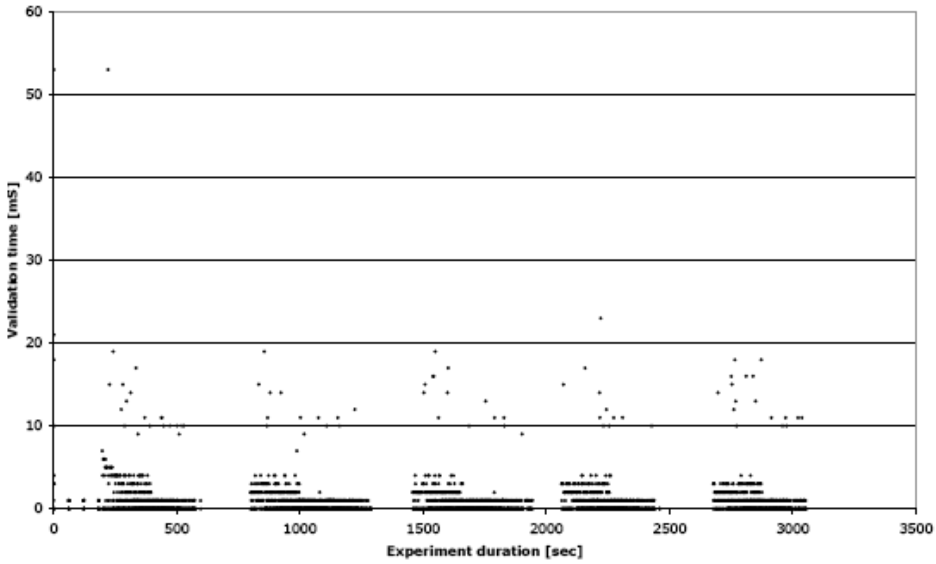
- Online monitoring per transition is efficient (constant in number of outgoing transitions per state).

See: F. Raimondi, J. Skene, W. Emmerich & B. Wozna: A Methodology for On-line Monitoring Non-Functional Requirements Specifications of Web Services. Proc. PROVECS Workshop at Tools Europe. Zurich. 2007.

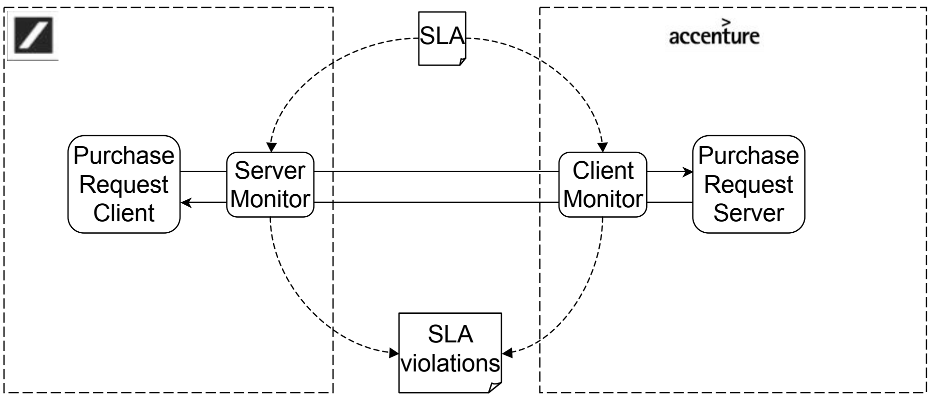
On-line monitoring Architecture

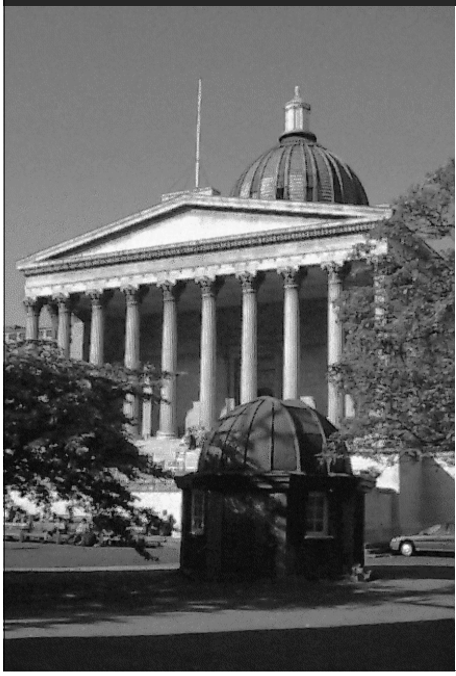


Performance



Summary





Ongoing Work

- SLAs with Virtualization:
- SLAs and Orchestration:
  - SLAs with service providers
  - A service composition

  What SLA can be offered for the composite service?

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